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CONSOLIDATED VERSION

VERSION CONSOLIDÉE

colour inside

Winding wires – Test methods – Part 2: Determination of dimensions

Fils de bobinage – Méthodes d'essai – Partie 2: Détermination des dimensions

IEC 60851-2:2009-09+AMD1:2015-05+AMD2:2019-05 CSV(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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WINDING WIRES –
TEST METHODS –

Part 2: Determination of dimensions

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This Consolidated version of IEC 60851-2 bears the edition number 3.2. It consists of the third edition (2009-09) [documents 55/1144/FDIS and 55/1163/RVD], its amendment 1 (2015-05) [documents 55/1520/FDIS and 55/1526/RVD] and its amendment 2 (2019-05) [documents 55/1681/CDV and 55/1737/RVC]. The technical content is identical to the base edition and its amendments.

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions and deletions are displayed in red, with deletions being struck through. A separate Final version with all changes accepted is available in this publication.

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International Standard IEC 60851-2 has been prepared by IEC technical committee 55: Winding wires.

This third edition constitutes a technical revision.

Technical revisions of note include recognition of the use of optical micrometers in determining the dimensions of round and rectangular enamelled wire.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 60851 series, under the general title *Winding wires – Test methods*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

This part of IEC 60851 forms an element of a series of standards which deals with insulated wires used for windings in electrical equipment. The series has three groups describing

a) methods of test (IEC 60851);

b) specifications (IEC 60317);

c) packaging (IEC 60264).

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WINDING WIRES –
TEST METHODS –

Part 2: Determination of dimensions

1 Scope

This part of IEC 60851 specifies the following method of test:

– Test 4: Dimensions.

For definitions, general notes on methods of test and the complete series of methods of test for winding wires, see IEC 60851-1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60851-1, *Winding wires – Test methods – Part 1: General*

IEC 60851-5:2008, *Winding wires – Test methods – Part 5: Electrical properties*

3 Test 4: Dimensions

3.1 Equipment

3.1.1 Round and rectangular wire

The equipment used shall have a resolution of 2 µm or less for wires over 0,200 mm and for wires up to and including 0,200 mm, a resolution of 1 µm or less. Both mechanical contact and optical non-contact micrometers may be used. If mechanical contact micrometers are used, the ratio of measuring force and anvil diameter shall be in accordance with the range as given in Table 1a and Table 1b. The diameter range of the spindle and anvil is also given in Table 1a and Table 1b. If optical micrometers are used, the average of the readings shall be recorded as the diameter of the conductor. If a specific measuring equipment must be used, it shall be agreed upon between the customer and the supplier.

Table 1 – Types of winding wires

Table 1a – Enamelled round wire

Type of winding wire	Nominal conductor diameter mm	Anvil diameter mm	Measuring force(N)/anvil diameter(mm) = P(N/mm)
Enamelled round wire	≤ 0,100	2 to 8	0,01 ≤ P ≤ 0,16
	0,100 < d ≤ 0,45	5 to 8	0,16 < P ≤ 0,32
	> 0,45	5 to 8	0,32 < P ≤ 0,80

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Table 1b – All the types of winding wires except enamelled round wire

Type of winding wire	Nominal conductor diameter mm	Anvil diameter mm	Measuring force N
Enamelled rectangular ~~and tape wrapped rectangular~~ wire	-	5 to 8	~~4 to 10~~ 2 to 4
Film tape wrapped round wire	≥ 0,100	5 to 8	~~1 to 8~~ 2 to 4
Film tape wrapped rectangular wire	-	5 to 8	2 to 4
Fibrous covered wire	-	5 to 8	~~4 to 10~~ 2 to 4
~~Paper covered wire~~	~~-~~	~~5 to 8~~	~~8 to 14~~

Table 1c – Paper covered wire

Type of winding wire	Nominal conductor diameter mm	Anvil diameter mm	Measuring pressure N/mm^2
Paper covered wire	-	5 to 8	1 to 2

For paper covered rectangular wire, a measuring pressure is considered more appropriate instead of a measuring force. Annex A provides for information a table with the relationship between force and pressure for a typical measuring range.

3.1.2 Bunched wire

The measurement shall be made with a polished conical mandrel having dimensions as shown in Figure 1.

3.2 Procedure

3.2.1 Conductor dimension

3.2.1.1 Round wire

NOTE See Table 2.

3.2.1.1.1 Nominal conductor diameter over 0,063 mm and up to and including 0,200 mm

From a straight piece of wire the insulation shall be removed at three places, 1 m apart, by any method that does not damage the conductor. One measurement shall be made at these three places.

The three single values shall be reported. The mean value represents the conductor diameter.

3.2.1.1.2 Nominal conductor diameter over 0,200 mm

From a straight piece of wire, the insulation shall be removed by any method that does not damage the conductor. Three measurements of the bare conductor diameter shall be made at points evenly distributed around the circumference of the conductor.

The three single values shall be reported. The mean value represents the conductor diameter.

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3.2.1.2 Rectangular wire

The insulation shall be removed at the three places used for measurements in 3.2.5.2 by any method that does not damage the conductor. At each place one measurement of the two dimensions of the conductor shall be made.

The three single values shall be reported for each dimension of the conductor. The mean represents the conductor width or the conductor thickness respectively.

3.2.2 Out-of-roundness of the conductor

Out-of-roundness is the maximum value of the difference between the three readings if measured in accordance with 3.2.1.1.1, or the three readings of the conductor diameter at the cross-section if measured in accordance with 3.2.1.1.2.The out-of-roundness shall be reported.

3.2.3 Rounding of corners of rectangular wire

For the purpose of this test, a cross-section of the wire shall be prepared and then examined under a sufficient magnification.

Three straight pieces of wire shall be cast in a suitable resinous compound that will not affect the insulation. After curing, the colour of the resinous compound shall contrast with the colour of the insulation.

The specimen consisting of the three pieces of wire embedded in the cured resinous compound shall be cut at right angles to the length of the wire pieces, and the cross-section shall be carefully ground and polished by suitable means. The polished surface shall be examined under a magnification which allows a correct judgement of the rounding of corners.

It shall be reported how the arc merges into the flat surface of the conductor. Any sharp, rough and projecting edges shall also be reported.

3.2.4 Increase in dimension due to the insulation

3.2.4.1 General

The increase in dimension due to the insulation is the difference between the overall dimension and the conductor dimension.

3.2.4.2 Round wire

The measurement shall be made in accordance with 3.2.1.1 and 3.2.5.1. The difference between the overall diameter and the conductor diameter shall be reported as the increase in diameter.

3.2.4.3 Rectangular wire

The measurement shall be made in accordance with 3.2.1.2 and 3.2.5.2. The difference between the overall width and the conductor width shall be reported as the increase in width. The difference between the overall thickness and the conductor thickness shall be reported as the increase in thickness.

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3.2.5 Overall dimension

3.2.5.1 Round wire

3.2.5.1.1 Nominal diameter up to and including 0,200 mm

On a straight piece of wire, at three places 1 m apart, one measurement of the overall diameter shall be made.

The three single values shall be reported. The mean value represents the overall diameter.

3.2.5.1.2 Nominal conductor diameter over 0,200 mm

On a straight piece of wire, at each of two places 1 m apart, three measurements of the overall diameter shall be made at points evenly distributed around the circumference of the wire.

The six single values shall be reported. The mean value represents the overall diameter.

For determination of the conductor diameter as given in the relevant standards, the following applies:

Table 2 – Determination of the conductor diameter

Nominal conductor diameter	Measurement	Clause
$d \leq 0{,}063$ mm	Resistance	3 of IEC 60851-5
$d > 0{,}063$ mm	Dimension	3.2.1.1
NOTE By agreement between purchaser and supplier, resistance measurements may be made in the range of nominal conductor diameters over 0,063 mm and up to and including 1,000 mm.		

3.2.5.2 Rectangular wire

On a straight piece of wire at each of three places at least 100 mm apart, one measurement shall be made of the two dimensions of the wire. Where the dimension of the specimen is greater than the diameter of the micrometer spindle, measurements shall be made both at the centre of the face of the specimen and over the edges. If these values differ, only the highest value shall be noted.

The three single values shall be reported for each dimension of the wire. The mean values represent the overall width or the overall thickness respectively.

3.2.5.3 Bunched wire

NOTE The method indicated below gives useful values in practice, but not an accurate overall diameter.

The overall diameter is the width of a layer wound on a mandrel divided by the number of turns. The bunched wire shall be wound closely on a mandrel according to Figure 1 and under a tension in newtons, which is 65 times the total nominal cross-section of the conductors in square millimetres. The width of the layer shall be not less than 10 mm for bunched wires with overall diameters up to and including 0,5 mm, and be not less than 20 mm for larger diameters and shall be measured with a precision of 0,5 mm.

One measurement shall be made. The overall diameter rounded off to 0,01 mm shall be reported.

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3.2.6 Increase in diameter due to the bonding layer of enamelled round wire

The increase in diameter due to the bonding layer is the difference of the overall diameter with and without the bonding layer.

The overall diameter of the wire shall be measured according to 3.2.5.1. After removal of the bonding layer by means of a solvent or any other suitable agent or by any other method which does not damage the underlying coating, the measurement shall be repeated. The difference of the two mean values shall be reported as the increase in diameter due to the bonding layer.

3.2.7 Increase in dimensions due to the bonding layer of enamelled rectangular wire

The increase in dimensions due to the bonding layer is the difference of the overall width or the overall thickness, respectively, with and without the bonding layer.

The overall width or the overall thickness, respectively, of the wire shall be measured according to 3.2.5.2. After removal of the bonding layer by means of a solvent or any other suitable agent or by any other method which does not damage the underlying coating, the measurement shall be repeated. The difference of the two mean values shall be reported as the increase in dimension due to the bonding layer.

Dimensions in millimetres

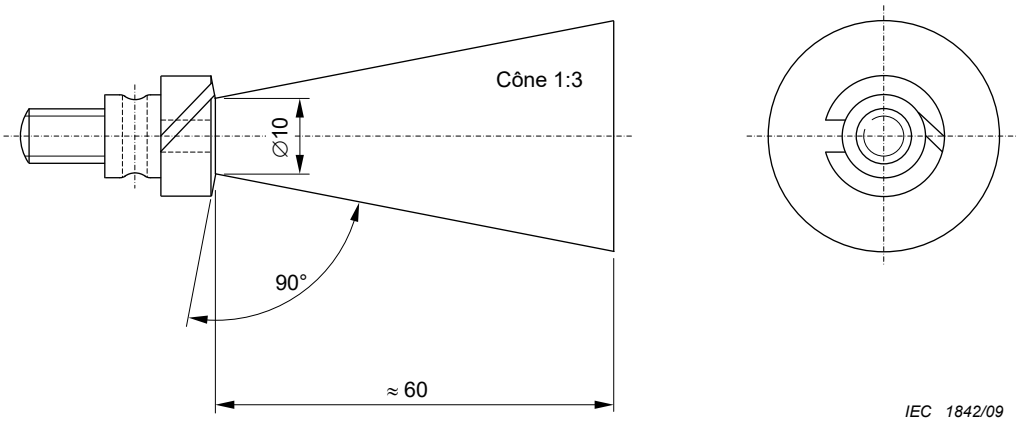

Figure 1 – Conical mandrel

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Annex A
(informative)

Table A.1 provides information, within a typical range, on the relationship between force and pressure applied to the wire according to Table 1c. Values outside the range of this table can be calculated using the following formula:

$p = F/A$

where:

p is the pressure, in N/mm^2;

F is the force, in N;

A is the section of the wire on which the force is applied, in mm^2.

Table A.1 – Relationship between force, pressure, anvil diameter and rectangular wire surface *(1 of 2)*

Force N	**Pressure** (N/mm^2)				
	Anvil diameter mm				
	5	**6**	**6,5**	**7**	**8**
	Surface mm^2				
	19,63	**28,26**	**33,17**	**38,47**	**50,24**
1	0,05	0,04	0,03	0,03	0,02
2	0,10	0,07	0,06	0,05	0,04
3	0,15	0,11	0,09	0,08	0,06
4	0,20	0,14	0,12	0,10	0,08
5	0,25	0,18	0,15	0,13	0,10
6	0,31	0,21	0,18	0,16	0,12
7	0,36	0,25	0,21	0,18	0,14
8	0,41	0,28	0,24	0,21	0,16
9	0,46	0,32	0,27	0,23	0,18
10	0,51	0,35	0,30	0,26	0,20
11	0,56	0,39	0,33	0,29	0,22
12	0,61	0,42	0,36	0,31	0,24
13	0,66	0,46	0,39	0,34	0,26
14	0,71	0,50	0,42	0,36	0,28
15	0,76	0,53	0,45	0,39	0,30
16	0,82	0,57	0,48	0,42	0,32
17	0,87	0,60	0,51	0,44	0,34
18	0,92	0,64	0,54	0,47	0,36
19	0,97	0,67	0,57	0,49	0,38
20	1,02	0,71	0,60	0,52	0,40

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Table A.1 *(2 of 2)*

Force N	Pressure (N/mm^2)				
	Anvil diameter mm				
	5	6	6,5	7	8
	Surface mm^2				
	19,63	28,26	33,17	38,47	50,24
21	1,07	0,74	0,63	0,55	0,42
22	1,12	0,78	0,66	0,57	0,44
23	1,17	0,81	0,69	0,60	0,46
24	1,22	0,85	0,72	0,62	0,48
25	1,27	0,88	0,75	0,65	0,50
26	1,32	0,92	0,78	0,68	0,52
27	1,38	0,96	0,81	0,70	0,54
28	1,43	0,99	0,84	0,73	0,56
29	1,48	1,03	0,87	0,75	0,58
30	1,53	1,06	0,90	0,78	0,60
31	1,58	1,10	0,93	0,81	0,62
32	1,63	1,13	0,96	0,83	0,64
33	1,68	1,17	0,99	0,86	0,66
34	1,73	1,20	1,03	0,88	0,68
35	1,78	1,24	1,06	0,91	0,70
36	1,83	1,27	1,09	0,94	0,72
37	1,89	1,31	1,12	0,96	0,74
38	1,94	1,34	1,15	0,99	0,76
39	1,99	1,38	1,18	1,01	0,78
40	2,04	1,42	1,21	1,04	0,80

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